

## TITLE OF THE INVENTION

[0001] Process for Production of a Hollow Body Connecting Element, Particularly a Fuel Tank Insert

## CROSS-REFERENCE TO RELATED APPLICATION

5 [0002] This is a division of co-pending U.S. Application No. 09/659,305, filed September 12, 2000, the disclosure of which is incorporated herein by reference.

## BACKGROUND OF THE INVENTION

[0003] The invention concerns generally a process for the production of a connecting element of thermoplastic material for connection to a hollow body also of thermoplastic material, and more particularly, but not exclusively, production of a component in the form of an insert which is adapted for lining a connection opening of a fuel tank and/or to form a seat for a connection element.

[0004] A fuel tank, for example for a motor vehicle, may typically include a component which lines a connection opening of the tank and/or which forms a seat for a connection element. Connection elements in that respect may be, for example, valves, nipples, connection sleeves and like members. Furthermore, a connection opening of the tank can be designed to accommodate a delivery or conveyor unit or it can be in the form of a sender opening for accommodating a sender for indicating the level of fuel in the tank, or in the form of a lead-in tube connection.

[0005] High demands are to be made on fuel tanks, in terms of their permeability in relation to hydrocarbons. In accordance with the most recent regulations relating to environmental protection, the total level of hydrocarbon emissions of a vehicle in the non-operating condition are to be not more than 0.5 g in a period of 24 hours. Correspondingly high demands are to be made in terms of the maximum level of hydrocarbon emission of a fuel tank system. For that reason fuel tanks may often be made by a co-extrusion blow molding process, wherein the wall thereof consists of a laminate with one or more barrier layers affording a low level of permeability to hydrocarbons. Such tanks generally satisfy the enhanced demands in regard to the maximum permissible levels of hydrocarbon emissions.

[0006] Problems are involved in this respect however in regard to the connection openings in the tank, which form a sealing seat for valves, connection portions and the like. As such connection openings have to involve close tolerances in order for example to guarantee a sufficiently sealing and play-free fit of a connection portion or valve therein, it is in many cases not possible to also

provide the valve seat or sealing seat for the connection component in one working operation in production of the tank by extrusion blow molding.

[0007] Accordingly, an opening is provided in the tank, to act as the connection opening. There are now various possible ways of inserting, for example, a valve into that opening in sealing relationship therewith. On the one hand, there is the possibility of screwing the valve against the tank wall, with the interposition of seals, which also bear against the tank wall structure. That arrangement is unsuitable for fuel tanks by virtue of the enhanced demands in terms of sealing integrity of the tank. Welding the valve to the tank also cannot be readily considered as valves and connection portions generally consist of POM (polyoxymethylene), in particular because of the need for the material to be resistant to the fuel, whereas the tank at least partially comprises PE (polyethylene). The various materials involved are not weldable to each other.

[0008] For that reason, nipples or valves consisting of POM may be provided with a stem which is injection-molded from PE and into which the valve or the connection nipple is fitted by clipping engagement. The stem can then be welded to the tank in the region of the connection opening thereof, for example by means of a hot plate welding procedure.

[0009] That manner of manufacture, however, still suffers from the disadvantage that the connection opening of the tank represents a weak point in regard to the possible emission of hydrocarbons as PE (polyethylene) is permeable in relation to hydrocarbons and swells up in the presence thereof whereas POM (polyoxymethylene) is scarcely pervious to hydrocarbons. A connection opening in the tank therefore still constitutes a source of emissions.

## BRIEF SUMMARY OF THE INVENTION

[0010] An object of the present invention is to provide a connecting element for insertion into a connection opening, for example an insert for a connection opening, which affords reduced hydrocarbons permeability, so that in use, for example, in a fuel tank the overall levels of hydrocarbon emissions of the tank are reduced.

[0011] Another object of the present invention is to provide an insert of thermoplastic material for use in conjunction with a fuel tank, such as to ensure compatibility between the materials involved and to provide a rational and readily implementable operating procedure for production of the assembly of such components.

[0012] Still a further object of the present invention is to provide an insert of thermoplastic material for connection to a hollow body of thermoplastic material, which is simple to produce while affording versatility of design configuration and operational function.

[0013] Yet a further object of the present invention is to provide a process for producing an insert for connection to a fuel tank of thermoplastic material, which is simple to implement and which can afford an insert of suitable nature for connection to a fuel tank affording low hydrocarbon-permeability.

5 [0014] In the insert aspect in accordance with the principles of the present invention the foregoing and other objects are attained by an insert of thermoplastic material for connection to a hollow body of thermoplastic material, for example in the form of a component for lining a connection opening of a fuel tank and/or for forming a seat for a connection element, wherein the insert is produced by press shaping of a laminate of low permeability for hydrocarbons.

10 [0015] It will be noted at this point that the term "press shaping" is used in accordance with the sense of the present invention to denote shaping an article of softened thermoplastic material, either in the form of an extrudate or in the form of a semi-finished article in softened form, in a mold which comprises a plurality of parts, preferably a two-part mold, consisting of a male mold portion and a female mold portion.

15 [0016] In accordance with a preferred feature of the invention the insert is adapted to be connected to a fuel tank by a connection involving intimate joining of the materials concerned, preferably being weldable thereto. That is guaranteed, in particular, if the insert comprises the same laminate as the tank. For connecting the insert to the fuel tank, a hot plate welding procedure, butt welding or sealing with heat reflectors or friction welding can be considered as appropriate welding  
20 processes, with hot plate welding being preferred.

[0017] Preferably, the insert comprises a laminate having at least one barrier layer for hydrocarbons. The barrier layer or layers can be at least almost completely embedded into the material of the insert. Preferably, the laminate has first and second barrier layers.

25 [0018] In a preferred feature, the barrier layers can be embedded in a main body, which substantially comprises polyethylene. This ensures that the main body is weldable to the material of the tank. The barrier layers should be arranged to extend in the material in such a way that, upon welding of the insert to the tank, they adjoin as closely as possible the barrier layers, which extend in the wall structure of the tank. Moreover, it is desirable for the barrier layers as far as possible to extend in the proximity of the inside wall of the insert, at an angle with respect to the longitudinal  
30 axis of the insert of an elongate configuration, so that migration of fuel around the barrier layer or layers can be very substantially prevented.

[0019] A further preferred feature of the invention provides that the barrier layer or layers comprises or comprise EVOH (ethylene vinyl alcohol). A container which is produced by a co-

extrusion blow molding process is to be found for example in DE 43 37 491 A1 to which reference is directed in terms of the full content thereof in regard to structure and lamination of the extrudate.

[0020] In the process aspect in accordance with the present invention the foregoing and other objects of the invention are attained by a process for producing an insert for sealing and non-

5 releasable connection to a fuel tank of thermoplastic material, wherein the insert is obtained by press shaping of a laminate with a low level of permeability for hydrocarbons.

[0021] Depending on the nature of the layer structure of the laminate used the finished insert may preferably include one or more barrier layers. Furthermore, the configuration of the one or more barrier layers in the insert is also dependent on the nature of the pressing tool, for example the  
10 position of the pressing tool division or the closing or squeeze-off portions of the tool.

[0022] Preferably a multi-layer preform is co-extruded and put into its definitive form by pressing in its first heat.

[0023] It is particularly desirable in accordance with the invention if the preform is extruded in the form of a tube having oppositely disposed walls, which are pressed against each other in the  
15 pressing molding operation. Such a tube is also extruded for example to produce the tank so that ultimately the insert can be produced using the same extrusion technology, simply requiring a different tool for producing the insert.

[0024] It will be appreciated that it is also possible to produce the insert from the scrap which occurs from the left-over portions of the tube in production of the tank using a co-extrusion blow  
20 molding process and which is cut off the tank after the blow molding procedure. That can be implemented in one working operation upon closure of the blow molding mold so that, when the blow molding mold is opened, the insert which has already been press shaped in the mold is obtained, besides the tank. For that purpose the blow molding mold is provided outside the mold cavity with the mold portions required for shaping the insert, that is to say, a male mold portion and  
25 a female mold portion.

[0025] Further objects, features and advantages of the invention will be apparent from the description hereinafter of preferred embodiments of the invention.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0026] The foregoing summary, as well as the following detailed description of the invention,  
30 will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there are shown in the drawings embodiments which are presently

preferred. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

[0027] Fig. 1 is a partly sectional view of a first embodiment of an insert according to the invention, which is welded to a tank and which has a valve fitted into the insert;

5 [0028] Fig. 2 is a sectional view of a second embodiment of an insert welded to a tank;

[0029] Fig. 3 is a sectional view of a third embodiment of an insert;

[0030] Fig. 4 is a sectional view of a fourth embodiment of an insert, with an angle connection portion fitted therein;

[0031] Fig. 5 shows a sectional view of an opened press shaping mold;

10 [0032] Fig. 6 shows a sectional view of the press shaping mold of Fig. 5 in the closed condition; and

[0033] Fig. 7 is a view on an enlarged scale of the portion indicated at VII in Fig. 3.

#### DETAILED DESCRIPTION OF THE INVENTION

[0034] Referring first to Fig. 1, reference numeral 1 therein generally denotes a first  
15 embodiment of an insert according to the invention, in the form of a hollow-cylindrical annular element having a cylindrical portion 2 and a collar 4 which forms a support flange 3.

[0035] Reference numeral 5 denotes the wall of a fuel tank which is produced by a co-extrusion blow molding process and to which the collar 4 of the insert 1 is welded in the peripheral region of a connection opening indicated generally at 6. The wall 5 of the fuel tank comprises a laminate, which  
20 is of low permeability in relation to hydrocarbons, with at least one barrier layer 7 of EVOH (ethylene vinyl alcohol). The barrier layer 7 provides a barrier action to prevent hydrocarbons from passing through the wall 5 of the tank.

[0036] The insert 1 shown in Fig. 1 and also in Fig. 2 also comprises a laminate which involves low permeability for hydrocarbons, with at least one barrier layer 7. The embodiments illustrated in  
25 Figs. 1 and 2 differ from each other insofar as the configuration of the barrier layer 7 in each of the two structures is selected to be different. It will be seen therefore that, in the embodiment shown in Fig. 1, the barrier layer 7 extends in the region of the cylindrical portion 2 of the insert 1 at an angle relative to the longitudinal axis of the insert 1 and is disposed at the lower end of the cylindrical portion 2 in the proximity of the inside wall 13 thereof. In the region of the collar 4 the barrier layer  
30 projects slightly above the support flange 3.

[0037] In the second embodiment of the invention as shown in Fig. 2, on the other hand, the barrier layer 7 more ideally firstly extends as closely as possible to and parallel to the inside wall

indicated at 13 in Fig. 1 of the insert 1. In the region of the collar 4 the barrier layer 7 extends as closely as possible to the outside of the insert 1 and ends fairly precisely in the outer corner region of the support flange 3.

[0038] Referring now to Fig. 3, the third embodiment of the insert 1 according to the invention as shown therein has a total of two barrier layers 7. The precise layer structure of the insert 1 of the Fig. 3 embodiment can be seen in greater detail from Fig. 7 to which further reference will be made below.

[0039] As the basic material of the insert 1 and also the tank is polyethylene, which swells in the presence of hydrocarbons, the insert 1 is provided with a metal support ring 8 which prevents a change in shape in the sense of an increase in the diameter of the insert 1, by virtue of the absorption of hydrocarbons, and which surrounds the insert 1 in a sleeve-like fashion. If the insert 1 should swell due to the presence of hydrocarbons thereat, then the insert 1 can only deflect or escape in an inward direction because of the existence of the metal support ring 8 forming a kind of hooping member around the insert 1, so that the connection to the wall 5 of the tank is not adversely affected. In addition the component which is disposed in the insert 1, for example a valve or some other component, does not experience any adverse effects in regard to its seat in the insert and the sealing integrity that is involved therewith.

[0040] In the embodiment of Fig. 1 the insert 1 is shown as serving as a sealing seat for a valve 9 of POM (polyoxymethylene). The valve 9 has a cylindrical main body 10 whose outside contour and whose outside diameter approximately correspond to the inside contour and the inside diameter of the insert, more specifically with a comparatively high level of dimensional accuracy. The main body 10 of the valve 9 is non-releasably latched to the insert 1 by way of retaining projections or catches 11. The valve 9 is sealed off in relation to the insert 1 by means of two O-ring seals 12, one of the O-ring seals being intended for the low-temperature range and the other for the high-temperature range.

[0041] As Fig. 2 in particular shows, the barrier layer 7 in the region of the support flange 3 is as far outward as possible in order to ensure, when the support flange 3 is welded to the wall 5 of the tank, that the barrier layer 7 of the insert 1 is connected to the barrier layer 7 of the wall 5 of the tank. At any event the barrier layer 7 should be embedded into the basic material of the insert 1 in order to be protected from physical damage.

[0042] The insert 1 shown in Fig. 4 is illustrated as receiving an angle connection portion 14 of POM (polyoxymethylene), instead of accommodating a valve. It will be noted here that, in regard to all the illustrated embodiments, the insert 1 shown is of a comparatively simple configuration having

a smooth inside wall 13, with either the angle connection portion 14 or the valve 9 being non-releasably latched to the insert 1. It is likewise conceivable for the insert 1 to be provided with a profiled internal wall, for example in the form of a screw thread, so that the connection element in question can be screwed to the insert 1.

5 [0043] Reference will now be directed to Figs. 5 and 6 diagrammatically showing the procedure for producing the insert 1. Reference numeral 15 denotes a mold or tool consisting of first and second parts, namely a male mold portion 16 and a female mold portion 17, which together form the pressing mold for producing the insert by a pressing shaping procedure. In accordance with the preferred form of the process, it is provided that the insert 1 is produced by extrusion of a multi-  
10 layer tube indicated at 18, using a co-extrusion procedure, with the tube 18 then being introduced into the tool 15 in the opened condition, as shown in Fig. 5.

[0044] The parts of the mold tool 15, that is to say the male mold portion 16 and the female mold portion 17, are moved towards each other, with the tube 18 filling the cavity 19 of the tool 15, as shown in Fig. 6. The closing forces, which are applied to the male mold portion 16 and the female  
15 mold portion 17, cause the excess material to be partially squeezed off and separated and partially driven into a compensating chamber 20. The tube, which is preferably co-extruded from six layers, is pressed together to form a structure which overall consists of twelve layers.

[0045] After the insert 1 is removed from the mold, the compensating volume of molded material, which is still attached thereto and which was produced by being expelled into the  
20 compensating chamber 20, as well as the lateral flash portions outside the mold cavity of the molding tool, have to be removed.

[0046] The finished insert of the structure is diagrammatically shown in Fig. 7, consisting of a total of twelve parallel layers, of which the two outer layers, as indicated at 21, comprise for example polyethylene, each then being adjoined by respective layers 22 of regenerated material. The  
25 term regenerated material is used to denote recycled material, which has occurred for example as scrap in production of the tank or in production of the insert 1.

[0047] The barrier layers 7, which comprise EVOH (ethylene vinyl alcohol), are respectively embedded into a primer or bonding layer 23 which ensures a join of the barrier layers 7 to the recycled material layers 22 or the outer layers 21 of polyethylene.

30 [0048] Production of the insert by way of a co-extruded tube, as indicated at 18 in Fig. 6, affords the structure involving a total of twelve layers, with all layers thereof being present at least in duplicate. The twelve-layer structure of the insert 1 is embodied only in the configuration shown in Fig. 3, in which there are a total of two barrier layers 7.

[0049] It will be noted that an insert as described hereinbefore in accordance with the invention has the advantage, over an insert which is only injection-molded from polyethylene, that it affords reduced permeability in relation to hydrocarbons on the one hand, while on the other hand such an insert according to the invention is comparatively simple to produce, for example using the multi-layer extrudate, which is present in any case in the manufacture of a tank by means of a co-extrusion blow molding process. It will be appreciated that as an alternative in relation thereto, it is possible, for producing the insert, to use a plate-shaped multi-layer semi-finished product or excess extrudate which occurs in blow molding of the tank.

[0050] It will be appreciated that the above-described configurations of the insert according to the invention and the process for production thereof in accordance with the invention have been set forth solely by way of example and illustration of the principles of the invention and that various other modifications and alterations may be made therein without thereby departing from the spirit and scope of the invention.